CLAIMS

What is claimed is:

1. A monitoring apparatus, comprising:

a housing;

a sensor unit located within said housing, said sensor unit configured to obtain depth measurements at periodic intervals;

a transceiver located within said housing; and

a processor located within said housing, said processor connected to said transceiver and configured to periodically transmit the depth measurements to a remote monitoring station.

2. The monitoring apparatus of claim 1, wherein said sensor unit comprises an ultrasonic sensor.

3. The monitoring apparatus of claim 1, wherein said sensor unit comprises an infrared sensor.

4. The monitoring apparatus of claim 1, further comprising a plurality of legs attached to said housing, said legs configured to secure said housing to an

interior surface of a manhole at a plurality of non-adjacent locations on said interior surface.

5. The monitoring apparatus of claim 4, wherein one or more of said legs is adjustable in length to facilitate securing the monitoring apparatus to said interior surface of the manhole.

6. The monitoring apparatus of claim 5, wherein said one or more legs comprise a flexible material which is compressable or bendable in order to allow leg length adjustment.

7. The monitoring apparatus of claim 5, wherein said one or more legs comprise a rotatable screw member for allowing adjustment of leg length.

8. The monitoring apparatus of claim 5, wherein said legs each comprise an adhesive foot to facilitate securing the monitoring apparatus to said interior surface of the manhole.

9. The monitoring apparatus of claim 1, further comprising a sensor window affixed to said housing, said sensor window providing a viewpath for said sensor unit.

10. The monitoring apparatus of claim 1, wherein said transceiver communicates with the remote monitoring station using a two-way pager communication technique.

11. The monitoring apparatus of claim 1, wherein said transceiver communicates with the remote monitoring station in a format compatible with a standard Internet protocol.

12. The monitoring apparatus of claim 1, wherein said transceiver comprises a directional antenna.

13. The monitoring apparatus of claim 1, further comprising a memory located within said housing for storing the depth measurements from said sensor, and wherein said processor is configured to periodically transmit the stored depth measurements to said remote monitoring station.

14. The monitoring apparatus of claim 1, further comprising a plurality of input/output ports.

15. The monitoring apparatus of claim 14, wherein said input/output ports are configured to receive input signals from one or more peripheral monitoring devices connectable to said monitoring apparatus, and wherein said processor is configured to convey said input signals, via said transceiver, to the remote monitoring station.

16. The monitoring apparatus of claim 15, wherein said one or more peripheral monitoring devices include a flowmeter.

17. The monitoring apparatus of claim 15, wherein said one or more peripheral monitoring devices include either or both of a heavy metal detector and a toxic gas detector.

18. The monitoring apparatus of claim 15, wherein said peripheral monitoring devices include a lab-on-a-chip.

19. The monitoring apparatus of claim 14, wherein said processor is programmable via one or more of said input/output ports.

20. The monitoring apparatus of claim 1, wherein said processor is programmable through remote instructions received from the remote monitoring station via said transceiver.

21. The monitoring apparatus of claim 20, wherein said remote instructions can alter a time interval between transmitted depth measurements from said monitoring apparatus.

22. The monitoring apparatus of claim 20, wherein said remote instructions can alter a sampling time interval between the depth measurements.

23. The monitoring apparatus of claim 20, wherein said processor is configured to operate according to a plurality of alertness modes distinguished by sampling rate of depth measurements or rate of transmitting to the remote monitoring station or both, and wherein said remote instructions can cause said processor to switch among said alertness modes, thereby altering the sampling rate of depth measurements or rate of transmitting to the remote monitoring station or both.

24. The monitoring apparatus of claim 1, further comprising a second sensor unit, said second sensor unit configured to detect if a manhole located above the monitoring apparatus, after the apparatus is installed beneath the manhole, is moved from its normal stationary position.

25. The monitoring apparatus of claim 24, wherein said second sensor unit comprises a pressure switch.

26. The monitoring apparatus of claim 24, wherein said second sensor unit comprises an optical or sonic presence detector oriented so as to point in an upwards direction when the apparatus is installed beneath the manhole.

27. The monitoring apparatus of claim 24, wherein said processor is configured to transmit a warning signal to the remote monitoring system when said second sensor unit detects that the manhole has been moved from its normal stationary position.

28. The monitoring apparatus of claim 1, wherein said housing is substantially formed of a water resistant, non-corrosive material.

29. A monitoring system, comprising:

a plurality of monitoring devices positioned within manhole cavities for measuring depth in the manhole cavities; and

a remote monitoring station configured to communicate wirelessly with said monitoring devices, said remote monitoring station receiving depth measurements at periodic intervals from said monitoring devices and durably storing said depth measurements.

30. The monitoring system of claim 29, wherein said monitoring devices measure depth at a programmed sample interval, and transmit the depth measurements at a programmed transmission interval longer than said sample interval.

31. The monitoring system of claim 30, wherein said monitoring devices are configured to compare depth measurements with a programmed alarm value and, if said alarm value is exceeded, to send a warning signal immediately to the remote monitoring station.

32. The monitoring system of claim 31, wherein said monitoring devices are configured to operate according to a plurality of modes, including at least a standard mode wherein the monitoring device operates to take depth

measurements at said programmed sample interval, and an alarm mode wherein the monitoring device operates to take depth measurements at a shorter sample interval.

33. The monitoring system of claim 29, wherein said monitoring devices are assigned unique identification numbers for distinguishing transmissions between the monitoring devices and the remote monitoring station.

34. The monitoring system of claim 29, wherein one or more of said monitoring device comprises an ultrasonic sensor for measuring depth.

35. The monitoring system of claim 29, wherein said monitoring devices communicate with the remote monitoring station using a two-way pager communication technique.

36. The monitoring system of claim 29, wherein said monitoring devices communicate with the remote monitoring station in a format compatible with a standard Internet protocol.

37. The monitoring system of claim 29, wherein one or more of said monitoring devices is coupled to a flowmeter and transmits data from the flowmeter to the remote monitoring station at periodic intervals.

38. The monitoring system of claim 29, wherein one or more of said monitoring devices comprises either or both of a heavy metal detector and a toxic gas detector and transmits data therefrom to the remote monitoring station at periodic intervals.

39. The monitoring system of claim 29, wherein one or more of said monitoring devices comprises a lab-on-a-chip and transmits data therefrom to the remote monitoring station at periodic intervals..

40. The monitoring system of claim 29, wherein said monitoring devices are programmable through instructions received wirelessly from the remote monitoring station.

41. The monitoring system of claim 29, wherein one or more of said monitoring devices are configured with a sensor to detect if a manhole located above the monitoring device is moved from its normal stationary position, and

are further configured to transmit a warning signal to the remote monitoring station when detecting that the manhole has been moved.

42. A method of monitoring, comprising the steps of:

placing a monitoring apparatus beneath a manhole, said monitoring apparatus comprising a sensor oriented in a downward direction when installed beneath the manhole;

obtaining depth measurements at a sampling interval and storing said depth measurements; and

wirelessly transmitting, at a transmission interval longer than said sampling interval, one or more of the accumulated depth measurements to a remote monitoring station for processing.

43. The method of claim 42, wherein said monitoring apparatus comprises a housing and a plurality of legs attached to said housing, and wherein said step of placing the monitoring apparatus beneath a manhole comprises the step of securing said legs to an interior surface of the manhole at a plurality of non-adjacent locations on said interior surface.

44. The method of claim 43, wherein one or more of said legs is adjustable in length to facilitate securing the monitoring apparatus to said

interior surface of the manhole, wherein said step of securing said legs to said interior surface of the manhole comprises the step of adjusting the lengths of one or more of said legs.

45. The method of claim 44, wherein said one or more legs comprise a flexible material which is compressable or bendable in order to allow leg length adjustment.

46. The method of claim 44, wherein said one or more legs comprise a rotatable screw member for allowing adjustment of leg length.

47. The method of claim 42, wherein said step of wirelessly transmitting one or more of the accumulated depth measurements to the remote monitoring station comprises the step of communicating between the monitoring apparatus and the remote monitoring station using a two-way pager communication technique.

48. The method of claim 42, wherein said step of wirelessly transmitting one or more of the accumulated depth measurements to the remote monitoring station comprises the step of communicating between the

monitoring apparatus and the remote monitoring station using a format compatible with a standard Internet protocol.

49. The method of claim 42, further comprising the steps of

connecting one or more peripheral monitoring devices to said monitoring apparatus; and

transmitting input signals from the peripheral monitoring devices to the remote monitoring station via the monitoring apparatus.

50. The method of claim 49, wherein said peripheral monitoring devices include one or more of a flowmeter, a heavy metal detector, and a toxic gas detector.

51. The method of claim 42, further comprising the step of re-programming the monitoring apparatus through commands received wirelessly from the remote monitoring station.

52. The method of claim 51, wherein said commands alter one or both of a time interval between transmitted depth measurements from said monitoring apparatus, and a sampling time interval between the depth measurements.

53. The method of claim 51, wherein said monitoring apparatus is configured to operate according to a plurality of alertness modes distinguished by sampling rate of depth measurements or rate of transmitting to the remote monitoring station or both, and wherein said method further comprises the step of causing the monitoring apparatus to switch among said alertness modes, thereby altering the sampling rate of depth measurements or rate of transmitting to the remote monitoring station or both.

54. The method of claim 42, further comprising the step of using a second sensor unit to detect if the manhole located above the monitoring apparatus is moved from its normal stationary position.

55. The method of claim 54, wherein said second sensor unit comprises a pressure switch.

56. The method of claim 54, wherein said second sensor unit comprises an optical or sonic presence detector oriented so as to point in an upwards direction when the apparatus is installed beneath the manhole.

57. The method of claim 54, further comprising the step of transmitting a warning signal from the monitoring apparatus to the remote monitoring system

when said second sensor unit detects that the manhole has been moved from its normal stationary position.

58. A self-contained monitoring apparatus, comprising:

a moisture-proof housing substantially formed of a water resistant, non-corrosive material;

means for obtaining depth measurements at periodic intervals;

means for durably storing said depth measurements; and

means for periodically and wirelessly transmitting the stored depth measurements to a remote receiver.

59. The self-contained monitoring apparatus of claim 58, further comprising means for adjusting, in response to commands received from a remote monitoring station, a time interval between depth measurements are obtained, and a time interval between transmissions of stored depth measurements to the remote monitoring station.